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Remarks:
Amended claims in accordance with Rule 86 (2) EPC.

(54) Passive response communication system

(57) A method of passive response communication, especially for an access control system, in which a first transponder (2) transmits an interrogation signal to a remote second transponder (3), which responds by transmitting data back to the first transponder (2), the two transponders each comprising a transmitter and a receiver, and a communication signal exchanged between said transponders (2, 3) in at least one direction including a plurality of anti-relay-attack pulses (13, 14). At least one distinguishing pulse (14) selected among the anti-relay-attack pulses has a distinctive shape and the receiver of said communication signal is selectively responsive to the shapes of said plurality of pulses (13, 14). Interception of the transmitted signal in a relay attack using digital transceivers will not relay the distinctive shape and the response of the second transponder is inhibited.

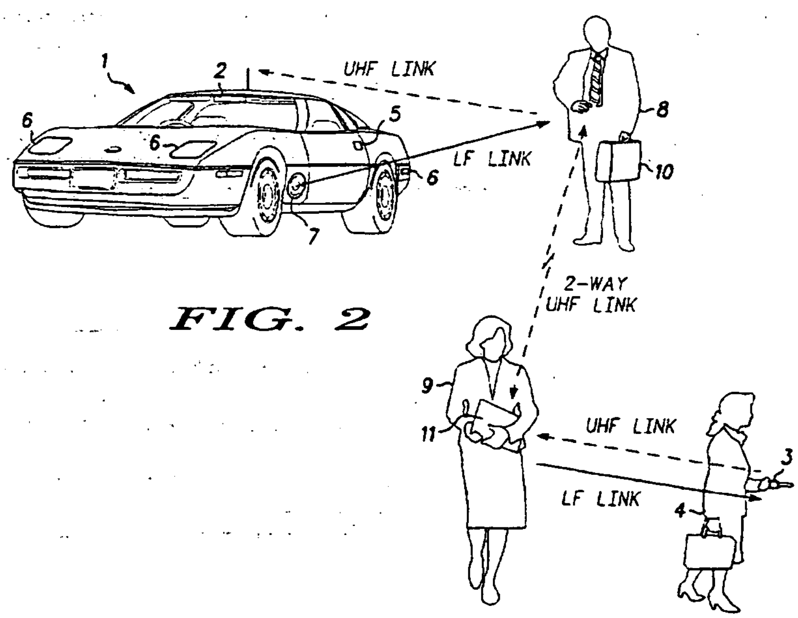

FIG. 2

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access control system in attempted fraudulent use as in Figure 2,

Figure 5 is a schematic diagram of one embodiment of a transmitter in a base station in the system of Figure 1,

Figure 6 is a diagram of signals generated by the base station transmitter of Figure 5,

Figure 7 is a schematic diagram of another embodiment of the transmitter in the base station in the system of Figure 1,

Figure 8 is a diagram of signals generated by the base station transmitter of Figure 7, and

Figure 9 is a schematic diagram of a receiver in a portable transponder device in the access control system of Figure 1.

Detailed description of the preferred embodiments

[0010] The embodiment of the invention shown in Figure 1 is an access control system for controlling physical access to a vehicle 1 and comprising a base station 2 installed in the vehicle and a portable transponder device 3 that is carried by the user 4 and preferably is integrated into a physical key. The physical key is usable for unlocking the vehicle, for example in the case of absence of electrical power or for actuating a physical immobiliser on the steering column.

[0011] The access control system is of the "RKE" - remote key entry - type, that is to say that the base station 2 controls the unlocking of locks 5 on the doors and other openings of the vehicle 1 by electrical actuators (not shown) in response to reception of a coded identification signal from the transponder device 2. In alternative embodiments of the present invention, the access control system controls disabling of vehicle immobiliser functions instead of, or in addition to, controlling physical entry into the vehicle. The control unit 2 is preferably also connected to actuate briefly lights 6 of the vehicle to confirm performance of the locking and unlocking operations of the vehicle 1.

[0012] The control unit 2 comprises a transmitter that will be described in more detail below, operating in the "LF" low frequency range, preferably at 125kHz, the transmitting antenna 7 being driven to transmit the H field, whose transmitting range is more easily controllable. The base station control unit 2 also includes a receiver (not shown) for receiving signals in the UHF range from the portable transponder 3. The portable transponder 3 includes an LF receiver that will be described in more detail below and a UHF transmitter (not shown).

[0013] For the purposes of locking the vehicle 1, the portable transponder device 3 includes a push-button (not shown) that may be actuated by the user 4 to transmit a signal over the UHF link to the base station control unit 2 to command locking of the car. Locking of the car is therefore performed using an active communication method.

[0014] For unlocking the vehicle, the base station unit 2 and the portable transponder device 3 normally communicate by a passive response communication method, although the push-button of the portable transponder device 3 may alternatively be used to trigger unlocking of the vehicle, for example from a distance beyond the range of the passive communication.

[0015] For passive communication, the access control system includes sensors (not shown) coupled to the door handles 5 of the vehicle and connected to the base station control unit 2 so that, when the user 4 pulls a door handle to open a door of the vehicle 1, a signal is sent from the corresponding sensor to the base station control unit 2. The base station control unit 2 responds to this signal by interrogating the portable transponder device 3, sending, for example, a wake-up signal followed by an interrogation signal, including an encrypted random or pseudo-random number and a base station identification code, followed by an anti-relay-attack field in accordance with this embodiment of the present invention.

[0016] In an alternative embodiment of the present invention, it is not necessary for the user 4 to actuate the door handle 5 to unlock the door. The base station 2 repeatedly transmits the interrogation signal and responds to the arrival of the user 4 within range of the LF transmitter and the corresponding reception of the user identification from the portable transponder device 3 to unlock the doors. In this embodiment of the invention, even the locking of the doors does not require any specific action by the user: the base station is connected to sensors (not shown) that respond to the opening and subsequent closure of the doors to transmit the interrogation signal repeatedly. The portable transponder device 3 responds as long as the user 4 is still within range of the LF transmitter and the base station 2 responds to the absence of the response of the portable transponder device 3 when the user 4 has moved out of range of the LF transmitter to lock the vehicle doors. The choice between the two embodiments depends on the preferences of the user 4.

[0017] The portable transponder device 3 receives the interrogation signal over the LF link and checks that the interrogation corresponds to a valid interrogation by its corresponding base station. If the interrogation is valid, the portable transponder device 3 responds by transmitting identification data that it has stored in a memory (not shown) over the UHF link to the base station control unit 2, the identification data being encrypted by a suitable method, preferably using the random or pseudo-random number transmitted by the base station control unit. The base station control unit 2 decrypts and checks the identification data transmitted by the portable trans-

selected as a function of a random or pseudo-random number at the base station control unit 2. An additional signal indicating the position of the modified pulse or pulses is encrypted and included in the anti-relay-attack field transmitted from the base station control unit 2 to the portable transponder device. The portable transponder device 3 will inhibit response with the identification data unless the position of the modified falling edge pulses in the anti-relay-attack field corresponds to the position indicated by the encrypted position signal.

[0026] The attempted fraudulent usage is shown in the drawings for the case of digital transmitters and receivers. It would be difficult for relays using an analogue transmission link to be used. If the relays have high Q-factor, a substantial delay will be added to the transmissions and can be detected by the base station checking an acknowledge signal which is transmitted back by the portable transponder device. Analogue relays with a low Q-factor are particularly difficult to implement.

[0027] Figure 5 shows a preferred embodiment of a transmitter in the base station control unit 2. The transmitter includes an antenna driver amplifier 27 that receives the LF pulsed signal to be transmitted. The amplifier 27 drives a tuned circuit comprising the transmit LF antenna 28 and a tuning capacitor 29 through a high resistance 30 of value R1. A switch 31 is connected in series with a resistance 32 of considerably lower value R2 than the resistance R1, the series combination of switch 31 and resistance 32 being connected to shunt the resistance 30 when the switch 31 is closed. A microprocessor 33 generates the interrogation signals including the anti-relay-attack field and applies the LF signals to be transmitted to the input of the antenna driver 27, selects one or more distinctive pulses 14 and applies a command signal to close the switch 31 temporarily during a few LF cycles at the falling edge of the selected distinguishing pulse or pulses 14.

[0028] Referring now to Figure 6, the LF driver input signal is shown at 34 for an anti-relay-attack pulse 14, the switch 33 closing at the falling edge of the distinctive pulse 14 as shown at 35, the LF magnetic field transmitted decaying thereafter rapidly, as shown at 36.

[0029] An alternative embodiment of the transmitter of the base station control unit 2 is shown in Figure 7. Once again, the antenna driver amplifier 27 supplies the tuned circuit of antenna 28 and capacitor 29 through resistance 30. As shown in Figure 8, in this case the microprocessor 33 inverts the phase of the driver signal 34 applied to the input of the amplifier 27 temporarily during a few LF cycles after the falling edge 37 of the distinctive pulse 14, shown at 38. The transmitted LF field then decays rapidly as shown at 39.

[0030] A preferred embodiment of the receiver at the portable transponder device 3 is shown in Figure 9. An LF tuned circuit comprising a receive antenna 40 and tuning capacitor 41 in parallel is connected to the input of a receiver amplifier 42. The signal from amplifier 42 is fed to an envelope detector 43, which has an output connected to a peak & threshold calculator 44 that measures the peak value of each pulse and calculates threshold definition values at 75%, 50% and 25% of the peak value. Another output of the envelope detector 43 is connected to a data recovery comparator 45 whose other input is connected to the 50% output of the peak & threshold calculator 44.

[0031] The receiver also comprises first and second threshold comparators 46 and 47 each having an input connected to the output of the envelope detector 43. The first threshold comparator 46 is also connected to the 25% output of the peak & threshold calculator 44 to provide a binary output when the output of the envelope detector 43 falls below (or rises above, in the case of a rising edge of a pulse) 25% of its peak value and the second threshold comparator 47 is connected to the 75% output of the peak & threshold calculator 44 to provide a binary output when the output of the envelope detector 43 falls below 75% of its peak value(or rises above, in the case of a rising edge of a pulse). The binary outputs from the threshold comparators 46 and 47 are supplied to an anti-relay-attack control unit 48 that measures the time that elapses between the binary signals from the second comparator 47 and the first comparator 46, for example by counting the number of clock pulses between these two events.

[0032] It would be possible for the receiver of the anti-relay-attack signals to respond to the absolute values of the fall times of the successive pulses. However it is preferred that the portable transponder device 3 responds to the difference between the rise and fall times of the anti-relay-attack signals pulses. More specifically, in the preferred embodiment of the invention, if dT is the difference between the rise and fall time of a pulse, it is preferred for the portable transponder unit to check the validity of the interrogation by comparing dT for one anti-relay-attack pulse with dT for another anti-relay-attack pulse. Thus, the number of clock pulses between the 75% and 25% levels of the received anti-relay-attack pulses will be subtracted for the rise and fall edges of a given anti-relay-attack pulse and the result of the subtraction compared between different anti-relay-attack pulses. Hence, in responding to the distinctive shape of the anti-relay-attack pulse or pulses selected by the base station control unit 2, the portable transponder device 3 responds to the rate of change of the edges of the received pulses and, more specifically, to the difference in the rate of change of the rising and falling edges of the anti-relay-attack signals. In particular it preferably responds to the variations between the distinguishing pulse and the other anti-relay-attack pulses. These rates of change are sensed by responding to the time elapsed between the moment that an edge reaches a first value and the moment that it reaches a second value, in the present embodiment the first and second values being the 25% and 75% values.

[0033] It will be appreciated that the embodiments of the present invention described offer an enhanced se-

response to receipt of said data from said second transponder.

15. A portable device for an access control system as claimed in claim 12 or 13 and comprising said second transponder (3) and means for storing said data.

1. A method of passive response communication in which a first transponder (2) transmits an interrogation signal to a remote second transponder (3), which responds by transmitting data back to the first transponder (2), the two transponders each comprising a transmitter and a receiver, and a communication signal exchanged between said transponders (2, 3) in at least one direction including a plurality of pulses (13,14),
characterised in that at least one edge of at least one distinguishing pulse (14) selected among said plurality of pulses has a rate of change different from the rate of change of a corresponding edge of at least another of said plurality of pulses so as to confer so as to confer a distinctive shape on said distinguishing pulse (14) and the receiver (Fig. 9) of said communication signal is selectively responsive to the shapes of said plurality of pulses (13, 14).

2. A method as claimed in claim 1, wherein the receiver (Fig. 9) of said communication signal is responsive to the time elapsed between the moment that said edge reaches a first value and the moment that said edge reaches a second value.

3. A method as claimed in claim 1 or 2, wherein said receiver (Fig. 9) is selectively responsive to relative values of both rise rate of change and fall rate of change of said plurality of pulses (13, 14).

4. A method as claimed in any preceding claim, wherein said receiver (Fig. 9) is selectively responsive to relative values related to the respective shapes of said at least one distinguishing pulse (14) and at least one other pulse (13) among said plurality of said pulses.

5. A method as claimed in claims 3 and 4, wherein said receiver (Fig. 9) is selectively responsive to relative values of the respective differences between the rise time and fall time of said plurality of pulses (13, 14).

6. A method as claimed in any preceding claim, wherein said at least one distinguishing pulse (14) is selected randomly or pseudo-randomly at the transmitter (Fig. 5, Fig. 7) of said communication signal and said communication signal includes an indication of which pulse is said at least one distinguishing pulse (14), the receiver (Fig. 9) of said communication signal being selectively responsive to the shape of a pulse corresponding to said indication.

7. A method as claimed in any preceding claim, wherein said communication signal is an electromagnetic signal and the transmitter (Fig. 5, Fig. 7) of said communication signal includes a tuned circuit (28, 29, 30) having a first quality factor and a resistive element (32) that is selectively connected with said tuned circuit (28, 29, 30) whereby to modify said quality factor and differentiate the shapes of said plurality of pulses.

8. A method as claimed in claim 7, wherein the fall time of said at least one distinguishing pulse (14) is shorter than the fall times of the others (13) of said plurality of pulses and said resistive element (32) is selectively connected with said tuned circuit (28, 29, 30) so as to reduce said quality factor at the falling edge of said at least one distinguishing pulse (14).

9. A method as claimed in any of claims 1 to 6, wherein the fall time of said at least one distinguishing pulse (14) is shorter than the fall times of the others (13) of said plurality of pulses and the transmitter (Fig. 7) of said communication signal includes means (33) for inverting the phase of the signal transmitted so as to reduce the fall time of said at least one distinguishing pulse (14).

10. A method as claimed in any preceding claim wherein said interrogation signal is a signal (34) of relatively low frequency and the signal transmitted back to said first transponder (2) is a signal of relatively high frequency.

11. A method of access control comprising communication between first and second transponders (2, 3) by a method as claimed in any preceding claim, and selectively enabling access in response to said distinctive shape of said distinguishing pulse (14).

12. An access control system for controlling access by a method including passive response communication as claimed in any preceding claim, comprising a base station (2) including said first transponder and a portable device (3) including said second transponder, said base station (2) being selectively responsive to reception of said data from said second transponder (3) to enable access.

13. An access control system as claimed in claim 11, wherein said communication signal is transmitted with said at least on distinguishing pulse (14) from said base station (2) to said portable device (3) and said portable device (3) is selectively responsive to the shapes of said plurality of pulses (13, 14) to send said data to said base station (2).

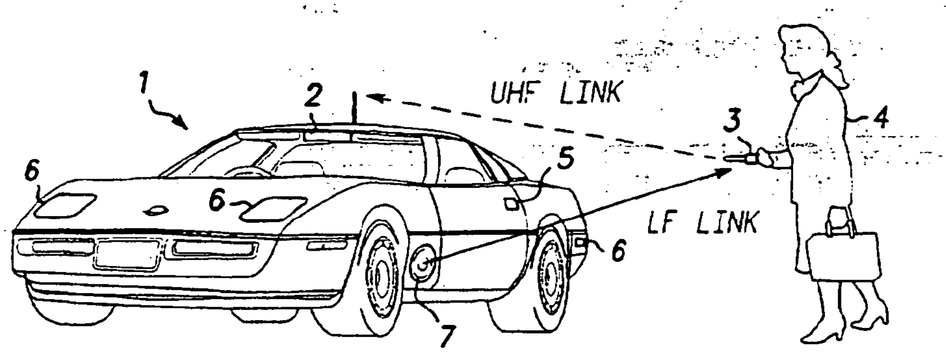
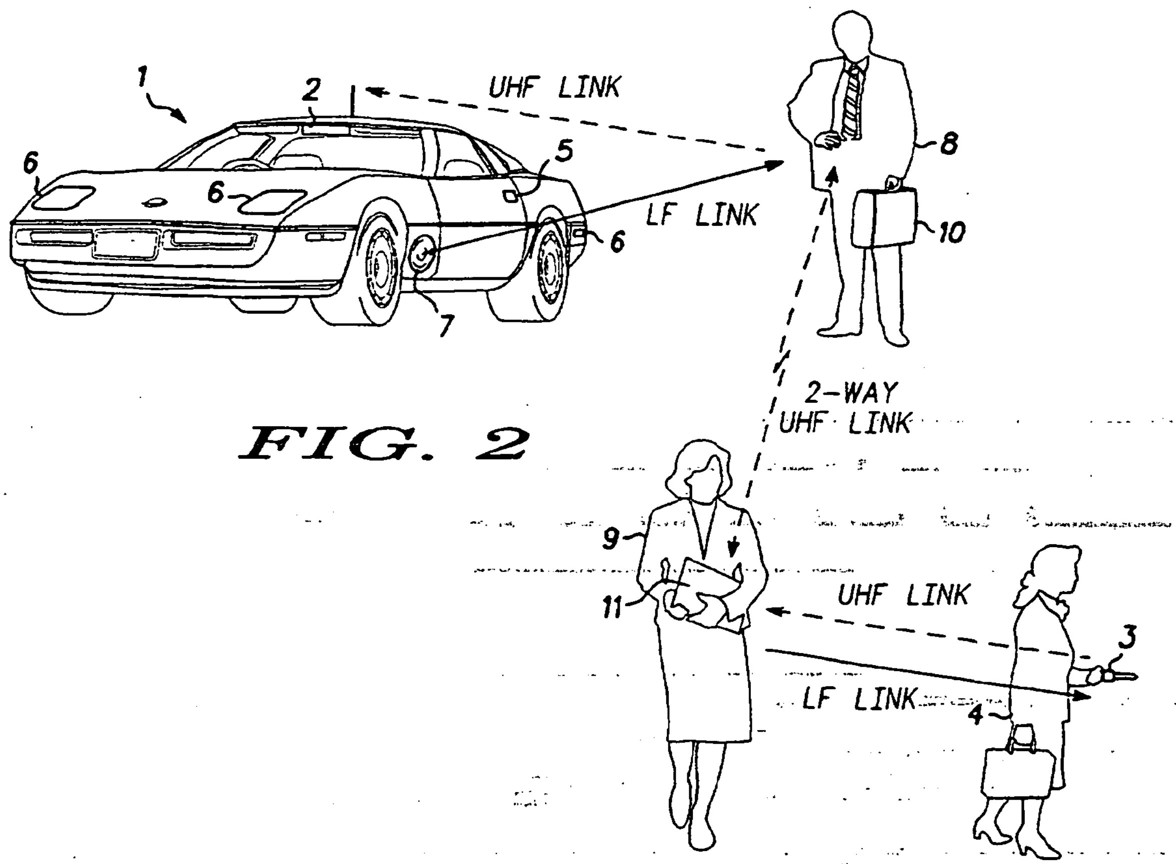

1
2
UHF LINK
3
4
6
5
6
LF LINK
6
7

FIG. 1


1
2
UHF LINK
6
5
6
8
LF LINK
6
10
7
2-WAY
UHF LINK
9
11
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3
LF LINK
4

FIG. 2

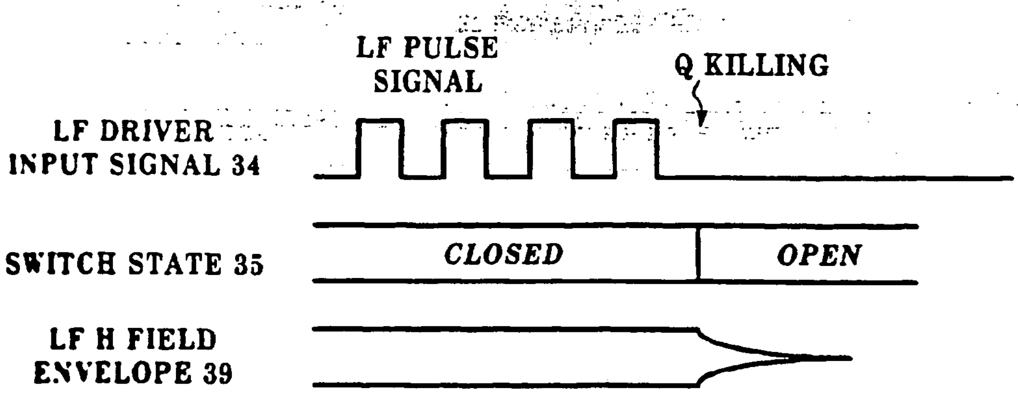

FIG. 6

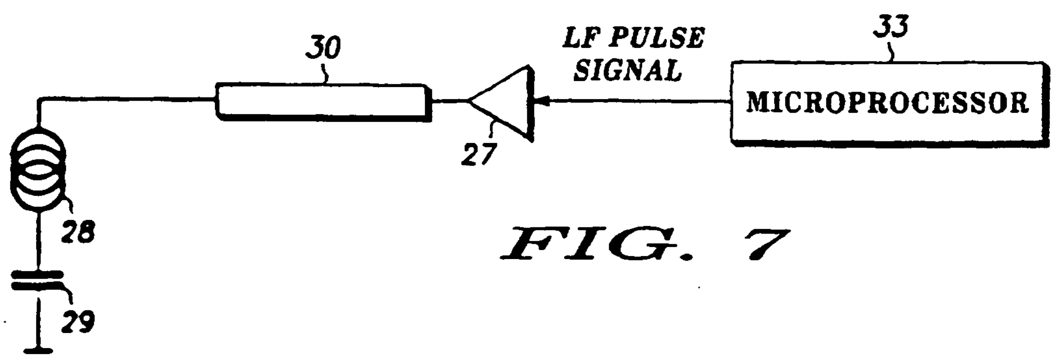

FIG. 7

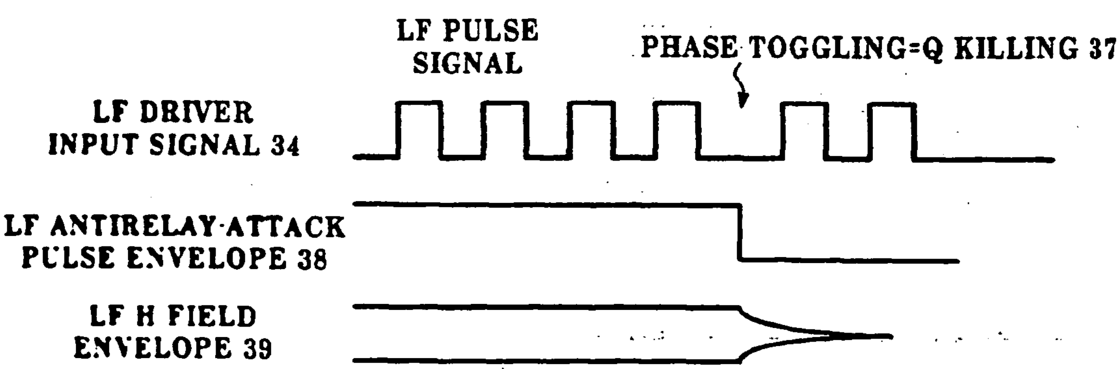

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 01 40 2260

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	WO 98 52142 A (BTG INT LTD ;MARIAS MARIO ALPHONSO (ZA); ATKINS RAYMOND CATHERALL) 19 November 1998 (1998-11-19) * page 11, line 17 - line 20; figure 9 *	1,5, 11-15	G06K7/00 G06K19/077 G08B13/24 G07C9/00
X	WO 90 07760 A (CHECKPOINT SYSTEMS INC) 12 July 1990 (1990-07-12) * page 22, line 29 - page 23, line 27; figure 8 *	1,5, 11-15	
A	US 3 961 322 A (LICHTBLAU GEORGE JAY) 1 June 1976 (1976-06-01) * column 3, line 57 - line 60; claim 1; figure 2D *	1-15	
A	EP 1 077 301 A (MOTOROLA SEMICONDUCTEURS) 21 February 2001 (2001-02-21) * the whole document *		
A	US 5 300 922 A (STOFFER JAMES F) 5 April 1994 (1994-04-05) * abstract *		TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	US 6 100 603 A (GOLD PETER) 8 August 2000 (2000-08-08) * abstract *		G06K G08B G07C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	8 February 2002	Fichter, U

CATEGORY OF CITED DOCUMENTS

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Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 6100603	A	08-08-2000	DE	19752029	A1	02-06-1999
			FR	2771358	A1	28-05-1999
			GB	2331671	A	26-05-1999
			JP	11324441	A	26-11-1999

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